## Chapter 9. Waste management.

Radioactive waste management is an important part of a Radiation Protection Program. There are few options for disposal of radioactive waste and all are costly. A well thought out waste management program will make radiation protection simpler and less expensive.

### 9-1. Regulation of Radioactive Wastes.

a. Oversight Agencies.

(1) The NRC regulates source, byproduct and special nuclear material only. Agreement States may include NORM and NARM within their jurisdiction. Congress mandated that states dispose of the radioactive waste generated within their borders. The states formed compacts to allow construction of one facility for the disposal of waste from all states within the compact. Compact commissions regulate the disposal of waste within their compact states and control the import and export of radioactive waste to and from their states.

(2) The EPA regulates radioactive material at CERCLA sites, in air emissions, and in drinking water. Legislation is underway to allow EPA to regulate allowable radiation exposure to the public from any man-made source.

(3) Table 9-1 is a listing of major laws and regulations pertinent to low level radioactive waste (LLRW) and mixed waste disposal, site remediation, and operational practices. The following paragraphs describe the various agencies propounding those regulations. This chapter is not an exhaustive description or listing of all applicable laws and regulations. Identification of applicable laws and regulations is a site-specific determination made only after full consultation with a regulatory specialist and Office of Counsel.

b. Department of Army.

(1) The U.S. Army Industrial Operations Command (AIOC), AMSIO-DMW, Rock Island, IL 61299-6000, has been appointed as the executing agent for disposal of DOD radioactive waste. The executing agent is responsible for inventorying and reporting all DOD waste disposal. The executing agent also serves as the POC for the disposal compacts and operates two DOD

TABLE 9-1
Low Level Radioactive Waste Laws and Regulations

| DOT | EPA | NRC | OSHA | DOE | DOD |
|---|---|---|---|---|---|
| Regulates interstate transportation of DOT defined radioactive materials (>2000 pCi/g). Title 49 | Regulates mixed waste, air and water emissions. Title 40 | Regulates source, byproduct, and special nuclear material; also applies DOT regulations to intrastate shipments of radioactive material. Title 10 | Regulates worker health and safety. Still applies old 10 CFR 20 regulations. Title 29 | Regulates radioactive material on DOE sites and nuclear weapons materials. Title 10 | Responsible for DOD licensed radioactive material and ARA authorized materials. AR 385-11 |

storage facilities for radioactive waste that cannot be disposed due to compact status.

(2) USACE is responsible for remediation of radioactive wastes at formerly used defense sites (FUDS), and at the discretion of the installation commander, for remediation of radioactive and mixed wastes on active and base realignment and closure (BRAC) listed bases. USACE is also involved with LLRW disposal during other DOD installation environmental restoration actions. USACE disposal of DOD LLRW waste must be coordinated through the HTRW-CX. The action will then be coordinated with the DOD executing agent for low-level radioactive waste disposal.

(3) Non-DOD (for example, RCRA Corrective Action) LLRW waste disposal will be coordinated with the HTRW-CX.

9-2. Low Level Radioactive Waste (LLRW).

a. LLRW is defined as all radioactive waste that is not high level waste or uranium or thorium mill tailings. This definition was enacted for purposes of determining methods of disposal of LLRW and high level radioactive wastes. Most radioactive waste USACE may manage is LLRW. LLRW should not be construed to present a low hazard. The hazards of radioactive wastes are determined by the type and quantity of radiation emitted.

b. Mixed Waste.

Mixed waste is defined as waste composed of NRC regulated radioactive materials mixed with RCRA (Resource Conservation and Recovery Act) listed hazardous wastes, and/or RCRA characteristic hazardous waste. The radioactive components of mixed waste

regulated by the NRC are source, byproduct or special nuclear material, and the hazardous component of mixed waste is regulated by EPA. A hazardous waste is defined in 40 CFR 261 as a solid waste which exhibits a hazardous characteristic, is "listed" in the regulations, or is a mixture of hazardous and solid wastes.

c. Radioactive material which is not source, byproduct or special nuclear material is not regulated by the NRC, but may be regulated by Agreement States, depending on the state laws. Hazardous wastes that are not RCRA listed or characteristic hazardous wastes may be regulated by the state as a hazardous waste under state hazardous waste management laws. The state does not need to be RCRA-authorized to establish this authority. When non-NRC regulated radioactive material is mixed with RCRA hazardous waste, or with state listed hazardous waste, or when NRC regulated radioactive material is mixed with state listed hazardous waste, the waste is considered to be combined waste, also called co-mingled waste.

d. The distinction between mixed and combined or co-mingled waste is important because the disposal options differ. There are a number of disposal options for combined or co-mingled waste, but only a few options for mixed waste.

e. Agreement States are listed in Table 4-2. LLRW compacts are shown on the map located in Appendix H.

f. Mixed Waste Amendment. The mixed waste amendment is found in Section 105 of the Federal Facilities Compliance Act of 1992. The amendment created a new mixed waste provision within RCRA. The amendment required DOE to submit a plan with schedules for all applicable permit applications, construction activities and processing of mixed waste at each of the DOE sites. Any USACE activity doing work for DOE should verify if a plan exists for the site and if there are any compliance schedules or permits in place. Examination of compliance schedules should include evaluating the hazardous portion regulated under RCRA. The RCRA compliance schedules may contain critical time-lines for USACE to meet in order to stay in compliance. The mixed waste amendment also required EPA or EPA authorized states to receive a copy of the mixed waste management plan for review and approval.

9-3. Elements of a Waste Management Program.

There are five elements of a radioactive waste management program. These elements are:

a. Material tracking;

b. Waste minimization;

c. Waste recycling;

d. Waste storage; and

e. Waste disposal.

9-4. Material Tracking.

Any project involving radioactive material will have a radioactive material tracking program in effect. This program will document the arrival on site of the radioactive material, the package receipt procedures, an active inventory of all materials and their locations at all times, all radioactive waste generated, and the final disposal of the radioactive material. Radioactive material will be tracked using the Record of Radioactive Material form (ENG 3309-R). On HTRW sites where there is radioactive contamination, the radioactive material will be entered into a tracking program as the contamination is containerized, or remediated. Each container will be labeled as described in Chapter 8, and tracked, from inception until final disposal at the disposal site.

9-5. Waste Minimization.

The most effective method of dealing with radioactive waste is to not generate it. This is often the case when using sealed sources. When working with unsealed sources or on HTRW sites this is usually not possible. Radioactive waste disposal costs are based on the cubic foot of waste at shallow land burial sites and by the gallon at incinerators, so there is a financial incentive to minimize the amount of waste produced and the volume of waste disposed. Where radioactive waste is generated or packaged, waste minimization techniques should be used. These techniques include avoiding equipment contamination, limiting the spread of contamination, decontamination of items where it is cost effective, efficient packing of bulky items and compaction or supercompaction where possible.

9-6. Waste Recycling.

A number of companies will recycle certain radioactive and mixed wastes. Sealed sources are often in demand by companies and universities. Radioactively contaminated metals can be smelted and cast as parts for disposal containers for other

radioactive wastes. If a project involves recyclable radioactive wastes, contact the HTRW-CX for a POC at the recycling companies.

9-7. Waste Storage.

Due to the status of some low level radioactive waste state compacts, there may be no disposal option for some radioactive wastes. Storage on site in most cases requires NRC or Agreement State licensing of the site and is generally not recommended. If the waste is a mixed waste, the RCRA time limit for storage on-site without a part B permit may be in effect. The US Army has contracted two facilities for long term storage of radioactive wastes. Neither facility has a Part B permit, so neither can store mixed, combined or co-mingled wastes. If long term storage is needed, contact the HTRW CX to arrange for use of the US Army facilities.

9-8. Waste Disposal.

a. Radioactive wastes can be disposed of in the following ways.

(1) An NRC licensed facility is allowed to release limited concentrations of radionuclides into the air or water. Small quantities can be disposed of in a sanitary sewer. Concentrations that can be disposed of by these methods are listed in Appendix B of 10 CFR 20.

(2) 10 CFR 20 also allows disposal of, and incineration of liquid scintillation fluids or animal tissue containing tritium or carbon-14 at concentrations of 0.05 microcurie per gram or less without regard to the radioactivity of the medium. Many liquid scintillation cocktails contain toluene or xylene which are RCRA hazardous wastes. The liquid scintillation cocktails that contain these, or other hazardous wastes, must still be disposed of as hazardous wastes.

(3) NRC licensed radioactive material which is considered waste and cannot be disposed of by the above methods, must be disposed of at a licensed LLRW disposal facility.

b. A classification system has been developed to segregate LLRW by hazard for disposal at near surface disposal sites. The hazard is based on the longevity and the radiation emitted. There are certain requirements to be met for all classes of LLRW, intended to facilitate handling and provide protection to the site personnel, the nearby public, and potential intruders into the disposal facility.

LLRW is classified as to the degree of rigor required for the disposal method.

(1) The acceptable physical characteristics of LLRW and the containers it is disposed in are determined by conditions on the disposal site's radioactive material license. Exemptions may be applied for and are granted if there is no increase in the hazards or risk to the public and environment.

(2) Some LLRW restrictions applied at disposal facilities include the following:

(a) Waste may not be packaged in cardboard or fiberboard boxes.

(b) Liquid LLRW must be solidified or packaged in sufficient absorbent material. Solid LLRW containing liquid shall contain as little free noncorrosive liquid as possible, not to exceed one percent by volume.

(c) LLRW must not be capable of detonation, explosion, or any other violent decomposition under ordinary disposal unit conditions.

(d) LLRW shall not contain or generate quantities of toxic fumes or gases during handling, transport, or disposal.

(e) LLRW must not be pyrophoric; waste containing pyrophoric materials shall be stabilized or treated to become a nonflammable waste.

(f) Gaseous LLRW must be packaged at less than 1.5 atmospheres pressure at 20 degrees Celsius and each container will not contain more than 100 Ci total.

(g) LLRW containing hazardous, biologic, pathogenic or infectious material must be treated to reduce the potential hazard from the non-radiological materials.

(h) LLRW must possess structural stability to avoid degrading the containment and the site. It will generally maintain its physical dimensions and form under the expected disposal conditions. Conditions to consider in assessing structural stability include weight of overburden, presence of moisture, microbial activity, radiation effects, and chemical changes. The waste form itself may provide structural stability before or after processing; or the waste may be placed in structurally stable containers or structures for disposal. Generally, only those stabilization media which have been evaluated according to the stability guidance requirements of the NRC's Low Level Licensing Branch, Technical Position on Waste Form, are considered acceptable

media. Liquid LLRW must be converted to a form containing as little free-standing and noncorrosive liquid as reasonably achievable. The volumetric content of the LLRW part of liquid or solid waste will not exceed 1 percent of a single container or 0.5 percent of the volume of waste processed to a stable form. Void spaces within the waste and between the waste and its package will be reduced as much as reasonably possible.

c. Class A LLRW.

(1) Class A LLRW is waste that does not contain sufficient amounts of radionuclides to be of concern with respect to migration, long term active site maintenance, and potential exposure to intruders. Class A LLRW tends to be stable. Class A LLRW is usually segregated from other waste classes at the disposal site. Class A LLRW must meet the minimum handling characteristics required and described above.

(2) Class A LLRW has concentrations less than columns 1 and 4 as shown in Table 9-2, Concentration/ Activity Levels for LLRW Classification.

d. Class B.

(1) Class B LLRW must meet more rigorous standards for stability than Class A. Class B LLRW is more highly radioactive than Class A.

(2)Class B LLRW has concentrations greater than column 1 and less than column 2 as shown in Table 9-2.

e. Class C.

(1) Class C LLRW must meet the most rigorous standards on waste form stability and additional measures at the disposal facility to protect against inadvertent intrusion.

(2) Class C LLRW has concentrations greater than column 2 and less than column 3, and less than column 5 as shown in Table 9-2.

f. Greater than Class C.

(1) Waste classified as greater than Class C is not suitable for near surface disposal.

(2) Greater than Class C LLRW has concentrations greater than column 5.

9-9. Radionuclide Concentrations.

Concentrations may be measured directly or calculated if there is reasonable assurance of correlation to direct measurements. Indirect methods of concentration determination include inference of one

nuclide concentration from that of another which is directly measured, and material inventory records. Concentrations may be averaged by weight or by volume.

Table 9-2
Concentration/activity levels for LLRW Classification

| Concentration Nuclide | Col. 1 $Ci/m^3$ | Col. 2 $Ci/m^3$ | Col. 3 $Ci/m^3$ | Col.4 $Ci/m^3$ | Col. 5 $Ci/m^3$ |
|---|---|---|---|---|---|
| C-14 | | | | 0.8 | 8 |
| C-14 activated metal | | | | 8 | 80 |
| Ni-59 activated metal | | | | 22 | 220 |
| Nb-94 activated metal | | | | 0.02 | 0.2 |
| Tc-99 | | | | 0.3 | 3 |
| I-129 | | | | 0 | 8 |
| TRU with halflife > 5 yrs. | | | | 10 nCi/g | 100 nCi/g |
| Pu-241 | | | | 350 nCi/g | 3500 nCi/g |
| Cm-242 | | | | 2,000 nCi/g | 20,000 nCi/g |
| all halflives < 5 yrs. | 700 | | | | |
| H-3 | 40 | | | | |
| Co-60 | 700 | | | | |
| Ni-63 | 3.5 | 70 | 700 | | |
| Ni-63 activated metal | 35 | 700 | 7000 | | |
| Sr-90 | 0.04 | 150 | 7000 | | |
| Cs-137 | 1 | 44 | 4600 | | |

Mixtures are determined by the sum of the fractions rule.